

REMARKS

These amendments and remarks are filed in response to the Office Action dated September 28, 2010. In view of these amendments and remarks, this application should be allowed and the case passed to issue. No new matter is introduced by the amendments. Claim 6 is amended to correct an informality.

Claims 1, 3-9, 14, and 16-19 are pending in this application. Claims 1, 3-9, 14, and 16-19 are rejected. Claim 6 is amended in this response. Claims 2, 10-13, and 15 were previously canceled.

Interview Summary

Applicants greatly appreciate the courtesy of Examiner Lee in granting an interview with the undersigned on December 7, 2010. During the interview, the undersigned discussed proposed claim amendment with the Examiner. In addition, the undersigned explained that Examples 1-3 and 1-4 were made by coprecipitation, as explained in the August 26, 2010 Amendment. The undersigned also explained the criticality of Examples 1-1 to 1-4 being formed by coprecipitation because the data in Table 4 established that it is the rapid heating and cooling which enables the twining portions to be formed. Examiner Lee agreed that Examples 1-3 and 1-4 were formed by coprecipitation and indicated she would reconsider the arguments and the evidence in Table 4 in the next response.

The undersigned further explained that Wada et al. do not disclose coprecipitation of transition metals because only one transition metal, Mn, is disclosed. The Examiner, however, explained that Wada et al. teach coprecipitation of Mn and Li. The undersigned further explained that coprecipitation of Mn, Ni, and Co provides a layered crystal structure where Mn, Ni, Co are uniformly dispersed and that Li is subsequently added to the Mn/Ni/Co structure. The

Li resided at interstices of the Mn/Ni/Co layered crystal, and the Li could easily enter into and exit from the Mn/Ni/Co structure during charge/discharge. The undersigned also explained that the present invention required a layered crystal structure while Wada et al. disclose a spinel crystal structure. The Examiner indicated that further consideration would be required upon the filing of a written response.

Claim Rejections Under 35 U.S.C. § 103

Claims 1, 3-8, 14, and 16-19 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ohzuku et al. (Chemistry Letters, CL-010390, Vol. 30 (2001), No. 7, pp. 642-43) (CL '390)) in view of Wada et al. (US 5,866,279). The Examiner found that CL '390 discloses a positive electrode material comprising $\text{LiCo}_{1/3}\text{Ni}_{1/3}\text{Mn}_{1/3}\text{O}_2$, and inherently discloses the crystalline properties. The Examiner further found that if the material of CL '390 were prepared according to the coprecipitation method of JP '813 the nickel, manganese, and cobalt would inherently be uniformly dispersed at the atomic level.

This rejection is traversed, and reconsideration and withdrawal thereof respectfully requested. The following is a comparison between the present invention, as claimed, and the cited prior art.

An aspect of the present invention, per claim 1, is a positive electrode active material comprising a lithium-containing composite oxide containing at least nickel and manganese elements, said positive electrode active material comprising primary particles of the composite oxide having a twinning portion, the composite oxide further contains cobalt element, and the nickel, manganese, and cobalt elements are uniformly dispersed at the atomic level. The composite oxide has a layered crystal structure and the arrangement of oxygen atoms is a cubic close-packed structure. The composite oxide contains nickel, manganese, and cobalt elements at

a ratio satisfying $\text{Co} / (\text{Ni} + \text{Mn}) \leq 1$. The lithium-composite oxide is formed by mixing a lithium compound with a composite hydroxide or oxide of nickel, manganese, and cobalt to form a mixture, rapidly heating the mixture, and subsequently quenching the mixture at a cooling rate of not less than 5 °C/min to 700 °C or lower.

The positive electrode active material of the present invention is not suggested by the combination of CL '390 and Wada et al. CL '390 and Wada et al., whether taken alone or in combination, do not suggest the composite oxide having a **twining portion** and the composite oxide further containing cobalt element, and the nickel, manganese, and cobalt elements are **uniformly dispersed** at the atomic level, the composite oxide has a layered crystal structure and the arrangement of oxygen atoms is a cubic close-packed structure, and the lithium-composite oxide is formed by mixing a lithium compound with a composite hydroxide or oxide of nickel, manganese, and cobalt to form a mixture, rapidly heating the mixture, and subsequently quenching the mixture at a cooling rate of not less than 5 °C/min to 700 °C or lower, as required by claim 1.

“Twining portion” is defined in the present written description as the interface between crystal grains and between crystal domains within a primary particle (specification at page 12, lines 2-8) (see FIGs. 4 and 5). Due to the presence of the twining portion within the primary particle of the active material of the present invention, lithium ions can enter and leave the positive electrode active material in every direction (see specification at page 16, lines 2-21).

Although the positive electrode active material in accordance with the present invention has a layered structure similar to LiCoO_2 , lithium ions can enter and leave in every direction of the particle by satisfying either of the above-mentioned two points (i.e. (i) and (ii)) or both thereof. This greatly reduces the polarization resistance involved in mass transport of lithium ions. As a result, it is possible to realize an active material with excellent rate capacity

(Specification, page 16, lines 14-21).

In general, when Ni, Mn, and Co are dispersed in an atomic level, and the individual Ni and Mn atoms are adjacent each other, Ni is present in a bivalent state and Mn is present in a tetravalent state. Because the bonding strength between a metal atom and an oxygen atom is dependent on the valences of the atoms, the interatomic distances of Ni-O, Mn-O, and Co-O are all different from one another. However, when Ni, Mn, and Co are orderly arranged, for example, in a crystal in which the crystal has sufficiently grown to form a superlattice, such differences in interatomic distances are well balanced.

In the present invention, rapid heating or rapid cooling (quenching) is performed in producing the particles. As disclosed in the present specification (page 28, lines 6-17):

In the method of producing the positive electrode active material in accordance with the present invention, an innovative control is performed during baking and cooling. Basically, rapid heating and quenching are performed in the present invention. It is preferred that rapid heating be performed at a rising temperature rate of not less than 7 °C/min and quenching be performed at a cooling rate of not less than 5 °C/min. Thereby, it is possible to control the grains within the primary particle as stated above. It is presumed that, when quenching is performed, oxygen loss occurs. Accordingly, it is preferred to perform heating treatment again at 700 to 750 °C in an air atmosphere.

The particle having experienced rapid heating or rapid cooling includes a number of interfaces between crystal grains and between crystal domains. The differences in the interatomic distances of Ni-O, Mn-O, and Co-O, as described above, are not balanced at these interfaces, causing the generation of distortion stress. This results in the occurrence of a twinning portion, thereby to produce the effect of the present invention. As disclosed in the present specification (page 17, lines 16-26):

Such defect and disorder are essential in order to obtain an excellent active material in accordance with the present invention. In the active material having such defect and disorder, the lattice repeatedly expands and contracts during charging/discharging. The stress due to the expansion and contraction generally breaks down the lattice, contributing a decrease in cycle life. In the present invention, however, the defect and disorder in the lattice allow the stress due to the expansion and contraction of the lattice to be relieved, resulting in an improvement in cycle life.

Accordingly, when there is no difference in the interatomic distance of Me-O, for example, in a LiCoO_2 crystal, which contains only one metal element, no twining occurs.

Neither CL '390 nor Wada et al. teach rapid heating or rapid cooling, as required by the present claims. If no rapid heating or rapid cooling is employed the grains or domains of the primary particle will grow sufficiently so that twining would not likely occur, as the interatomic distances of Ni-O, Mn-O, and Co-O would be well balanced.

Example 1-4 corresponds to Ni-Mn-Co based active materials in CL '390. Examples 1-1 and 1-2, which are formed by rapid heating and rapid cooling exhibit unexpectedly improved rate performance and a cycle performance. For the Examiner's convenience, Table 4 is reproduced below.

Table 4

EX.	Composition	Electric capacity	Rate performance	25°C cycle	Note
1-1	$\text{Li}[\text{Li}_{0.03}(\text{Ni}_{1/2}\text{Mn}_{1/2})_{0.97}]\text{O}_2$	107	93	81	Rapid heating/quenching
1-2	$\text{Li}[\text{Li}_{0.03}(\text{Ni}_{1/3}\text{Mn}_{1/3}\text{Co}_{1/3})_{0.97}]\text{O}_2$	111	95	80	Rapid heating/quenching
1-3	$\text{Li}[\text{Li}_{0.03}(\text{Ni}_{1/2}\text{Mn}_{1/2})_{0.97}]\text{O}_2$	104	88	72	No quenching
1-4	$\text{Li}[\text{Li}_{0.03}(\text{Ni}_{1/3}\text{Mn}_{1/3}\text{Co}_{1/3})_{0.97}]\text{O}_2$	105	89	70	No quenching
Comp. Ex. 1	$\text{Ni}(\text{OH})_2 + \text{MnOOH}$ compound	92	72	52	-
Comp. Ex. 2	LiCoO_2	100	85	63	-

In the Response to Arguments section of the May 26, 2010 final Office Action, it was noted that the claims did not require rapid heating or cooling and that there did not appear to be a direct correlation between rapid heating or cooling and the formation of the twining portions. In addition, the Examiner found that Examples 1-3 and 1-4 were not formed by coprecipitation in both the May 26, 2010 final Office Action and the September 28, 2010 Office Action. Claim 1 requires rapid heating and cooling. As regards Examples 1-3 and 1-4, as disclosed in the specification at page 50, lines 20-26, these examples were made in the same manner as Examples

1-1 and 1-2 (coprecipitation), but they were not subject to rapid cooling. Comparative Examples 1 and 2 were not made by coprecipitation.

As explained during the December 7, 2010 telephone interview:

(1) Examples 1-3 and 1-4 were made by coprecipitation but were not subjected to rapid heating and cooling, which is evidence that the twining portions were formed as a result of rapid heating and cooling. Thus, the formation of twining portions is not inherent in the prior art, as the formation of the twining portions depend on the manner in which the material was made.

(2) Wada et al. do not disclose coprecipitation of composite hydroxides or oxides of transition metals. In the present invention, a composite hydroxide or oxide of nickel, manganese, and cobalt is coprecipitated. Wada et al., however, cannot teach coprecipitation of nickel, manganese, and cobalt oxides or hydroxide because Wada et al. disclose forming $\text{LiMn}_{2-x}\text{Li}_x\text{O}_4$. Only one transition metal, Mn, is in the positive electrode active material of Wada et al. Thus, there can be no coprecipitation of a plurality of transition metal oxides or hydroxides because only one transition metal can be precipitated in the Wada et al. material.

In an oxide that does not contain two or more transition metal elements, no twining portion is formed because there is almost no difference in interatomic distance M-O, as explained in the August 26, 2010 response (pages 7-8). For example, no twining occurs in a LiCoO_2 , which contains only one transition metal.

(3) Claim 1 requires a layered crystal structure. Wada et al. discloses a spinel crystal structure. It would not have been obvious to apply a method of producing a spinel structure to the composite oxide of the present invention having a layered crystal structure.

In response to points raised by the Examiner during the interview, coprecipitation as disclosed by Wada et al. is different from the claimed coprecipitation. Although coprecipitation

is taught in Example 7 of Wada et al., the resultant of the Wada et al. coprecipitation is a powder mixture comprising two different types of compounds, as disclosed by Wada et al. (col. 9:7-8), "a powder mixture of $\text{Li}_2(\text{C}_2\text{O}_4)$ and $\text{Mn}(\text{C}_2\text{O}_4)$."

The reason only a powder mixture comprising two kinds of compounds is obtained is because Li ions and Mn ions differ in valance (Li: 1, Mn: 2) and in size. Li and Mn also differ in chemical properties. Therefore, Li and Mn do not disperse uniformly at the atomic level in one particle. The resultant powder of a mixture of Li and Mn compounds would be a powder mixture of two kinds of compounds.

In the present invention, on the other hand, Ni, Mn, and Co are coprecipitated. These are all transition metals comprising ions of the same valance (2) and the same size. Therefore these three transition metal elements can be uniformly dispersed at the atomic level in a single crystal. The Ni, Mn, and Co would be allocated at the atomic level to the same site in each crystal lattice in accordance with the ratio at which element is formulated. Thus, single particles each having a composition of $(\text{Ni}_{1-x-y}\text{Mn}_x\text{Co}_y)(\text{OH})_2$ would be obtained. The single particles are subsequently mixed with $\text{LiOH}\cdot\text{H}_2\text{O}$ particles and baked.

In Wada et al. there are two different particles, $\text{Li}_2(\text{C}_2\text{O}_4)$ and $\text{Mn}(\text{C}_2\text{O}_4)$ mixed together prior to baking, while in the present invention, a single particle, $(\text{Ni}_{1-x-y}\text{Mn}_x\text{Co}_y)(\text{OH})_2$ comprising the three transition metal elements is mixed with $\text{LiOH}\cdot\text{H}_2\text{O}$ prior to baking. Coprecipitation according to Wada et al. does not provide plural kinds of transition metal elements (Ni, Mn, and Co) uniformly dispersed at the atomic level, inside a single particle.

Furthermore, in the present invention, the lithium is added to Mn/Ni/Co crystal structure after the three transition metal matrix is formed. Thus, the lithium is not tightly bound to the crystal structure backbone, and can easily enter into and exit from the crystal interstices during

charge/discharge. In addition, Wada et al. teach (col. 3, lines 35-37), "[t]he lithium manganese oxide of the present invention is the one obtained by a special combination of specific starting materials and a specific production process," thus, Wada et al. teach away from the disclosed coprecipitation being generally applicable to the formation of a three-transition metal-containing, layered crystal structure.

In view of the above, it is readily apparent that the cited references do not suggest the claimed twining portion. It is further clear that the cited references do not suggest the unexpected improvement in rate and cycle performance, as shown in Table 4.

As explained above, the combination of CL '390 and Wada et al. do not suggest that the cobalt, nickel, and manganese are inherently uniformly dispersed. The Office Action found that the combination of CL '390 and Wada et al. inherently disclose the claimed material. However, the fact that a certain result or characteristic may occur or be present in the prior art is not sufficient to establish the inherency of that result or characteristic. *In re Rijckaert*, 9 F.3d 1531, 1534, 28 USPQ2d 1955, 1957 (Fed. Cir. 1993). The principal of inherency is inapplicable when teachings from a plurality of references are combined to obtain all the claim limitations necessary to provide the asserted inherent feature. As is clear from the MPEP and Federal Circuit caselaw, that which is asserted as inherent must be found in a single reference. The Office Action, however, alleges inherency based on a combination of references.

As taught in MPEP § 2112 "[t]he express, implicit, and inherent disclosures of a prior art reference may be relied upon in the rejection of claims under 35 U.S.C. 102 or 103. "The inherent teaching of a prior art reference, a question of fact, arises both in the context of anticipation and obviousness." *In re Napier*, 55 F.3d 610, 613, 34 USPQ2d 1782, 1784 (Fed. Cir. 1995) (affirmed a 35 U.S.C. 103 rejection based in part on inherent **disclosure in one of the**

references). See also *In re Grasselli*, 713 F.2d 731, 739, 218 USPQ 769, 775 (Fed. Cir. 1983)" (emphasis added). In both *Napier* and *Grasselli* the Court found an inherent disclosure in **one** of the references. In the present application, however, the Office Action asserts an inherent disclosure based on the combined teachings of a plurality of references, *Ohzuku et al.* (CL '390) and *Wada et al.* The Office Action's assertions of inherency are contrary to the established law of inherency, as explained in the MPEP.

As recognized by the Office Action, the fact that a certain result or characteristic may occur or be present in the prior art is not sufficient to establish the inherency of that result or characteristic. *In re Rijckaert*, 9 F.3d 1531, 1534, 28 USPQ2d 1955, 1957 (Fed. Cir. 1993). "Inherency . . . may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient." *In re Robertson*, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999)(citations omitted). When teachings from a plurality of references are combined to obtain all the claim limitations, inherency can not be asserted because whether or not a certain property is present depends on the specific features from each reference that are combined. Because the final product depends on which features are selected from Reference A and Reference B, the final product may or may not necessarily end up with the claimed property. Inherency requires that the product **necessarily** has the claimed property. In view of the many different possible combinations possible when combining two different references it is not possible to say that the combination of the references will necessarily result in a product inherently having the claimed property. If different features of the plurality of references are selected to be combined it is possible that the asserted property would not result. If it is possible that the asserted property would not result, then it cannot be an inherent property, as an inherent property must necessarily be present.

Obviousness can be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. *In re Kahn*, 441 F.3d 977, 986, 78 USPQ2d 1329, 1335 (Fed. Cir. 2006); *In re Kotzab*, 217 F.3d 1365, 1370 55 USPQ2d 1313, 1317 (Fed. Cir. 2000); *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992); *In re Fine*, F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988). CL '390 and Wada et al. do not suggest positive electrode active material comprising primary particles of the composite oxide having a twinning portion, containing cobalt element, and the nickel, manganese, and cobalt elements are uniformly dispersed at the atomic level, the composite oxide has a layered crystal structure and the arrangement of oxygen atoms is a cubic close-packed structure, and the lithium-composite oxide is formed by mixing a lithium compound with a composite hydroxide or oxide of nickel, manganese, and cobalt to form a mixture, rapidly heating the mixture, and subsequently quenching the mixture at a cooling rate of not less than 5 °C/min to 700 °C or lower, as required by claim 1.

The only teaching of the claimed positive electrode active material comprising primary particles of the composite oxide having a twinning portion, containing cobalt element, the nickel, manganese, and cobalt elements are uniformly dispersed at the atomic level, the composite oxide has a layered crystal structure and the arrangement of oxygen atoms is a cubic close-packed structure, and the lithium-composite oxide is formed by mixing a lithium compound with a composite hydroxide or oxide of nickel, manganese, and cobalt to form a mixture, rapidly heating the mixture, and subsequently quenching the mixture at a cooling rate of not less than 5 °C/min to 700 °C or lower is found in Applicants' disclosure. However, the teaching or

suggestion to make a claimed combination and the reasonable expectation of success must not be based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

Claim 9 was rejected under 35 U.S.C. § 103(a) as being unpatentable over CL '390 in view of Wada et al. and Miyasaka (US 6,416,902). This rejection is traversed, and reconsideration and withdrawal thereof respectfully requested.

The combination of CL '390, Wada et al., and Miyasaka do not suggest the claimed positive electrode active material because Miyasaka does not cure the deficiencies of CL '390 and Wada et al. Miyasaka does not suggest the composite oxide having a **twining portion** and the composite oxide further containing cobalt element, and the nickel, manganese, and cobalt elements are **uniformly dispersed** at the atomic level, the composite oxide has a layered crystal structure and the arrangement of oxygen atoms is a cubic close-packed structure, and the lithium-composite oxide is formed by mixing a lithium compound with a composite hydroxide or oxide of nickel, manganese, and cobalt to form a mixture, rapidly heating the mixture, and subsequently quenching the mixture at a cooling rate of not less than 5 °C/min to 700 °C or lower, as required by claim 1.

The dependent claims are allowable for at least the same reasons as independent claim 1, and further distinguish the claimed positive electrode active material. For example, new claim 19 further requires during the rapidly heating the mixture, the temperature of the mixture is increased at a rate of not less than 7 °C/min. The cited references do not suggest this additional limitation.

In view of the above remarks, Applicants submit that this application should be allowed and passed to issue. If there are any questions regarding this response or the application in

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general, a telephone call to the undersigned would be appreciated to expedite the prosecution of the application.

To the extent necessary, a petition for an extension of time under 37 C.F.R. § 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

McDERMOTT WILL & EMERY LLP



Bernard P. Codd
Registration No. 46,429

600 13th Street, N.W.
Washington, DC 20005-3096
Phone: 202.756.8000 BPC:kap
Facsimile: 202.756.8087
Date: December 28, 2010

**Please recognize our Customer No. 53080
as our correspondence address.**